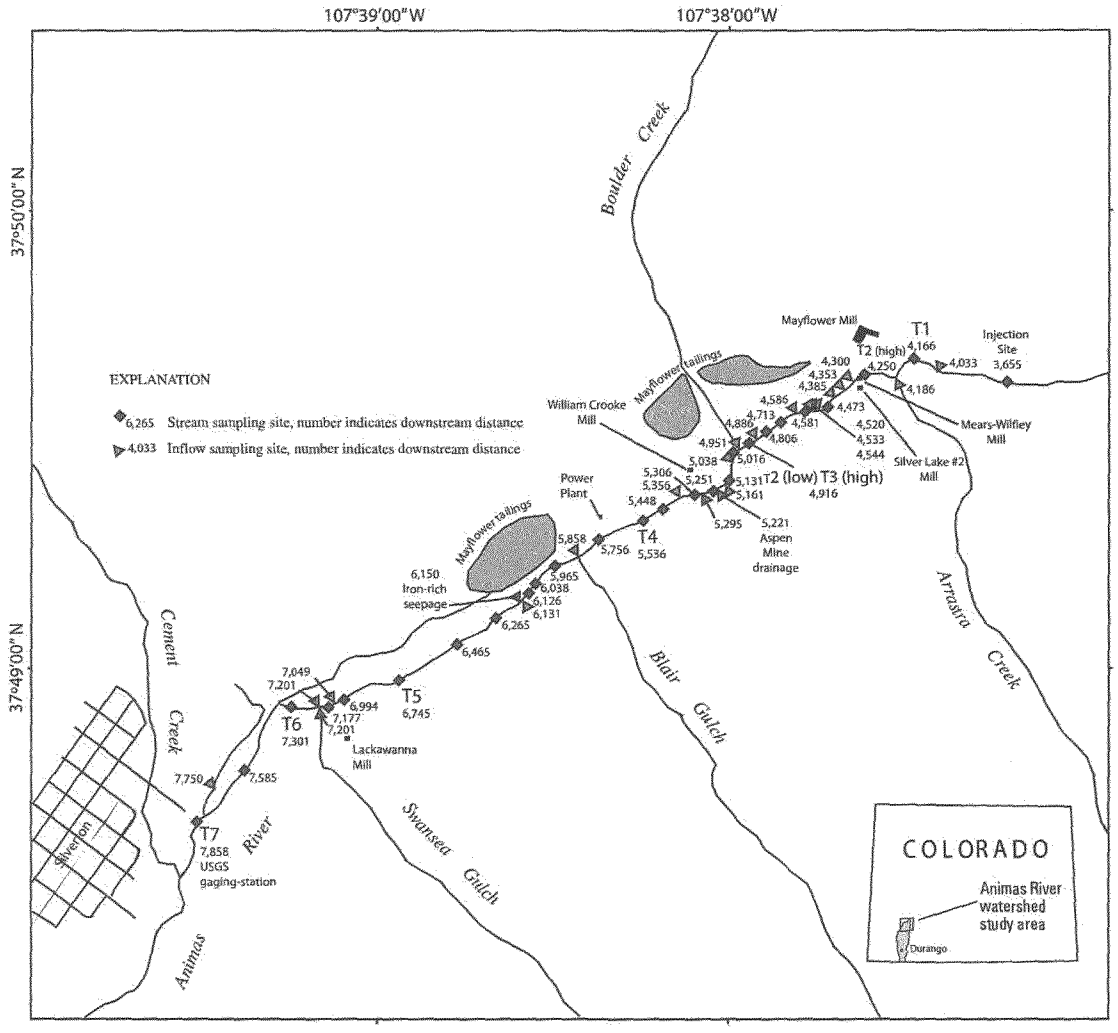

Fig. 1. Location of study reach and sampling sites along the Animas River, August 2002 and April 2003. All sites were sampled in 2002, but only the transport sites (T1–T7) were sampled during high flow in 2003 (see Table 1).

tion of stream-water quality under relative steady conditions. Personnel limitations precluded simultaneous sample collection for so many sites. The low-flow synoptic study, however, is accomplished over a relatively short time (usually less than 8 h) in an effort to minimize effects of diel flow variation. Sampling at low flow can begin when the tracer concentration has reached a relatively constant concentration over time. The assumption of constant conditions for the tracer can be affected by diel variations due to evapotranspiration, but in general, this diel variability only affects tracer concentrations when stream flow is less than a few liters per second. Because the sampling includes both filtered and total-recoverable concentrations, the approach is to work from downstream to upstream to prevent stirring up Fe-rich colloidal material from the streambed. Inflow sites that were considered well mixed were sampled using grab techniques. Stream sites were sampled using equal-width integration techniques (Ward and Harr, 1990).

2.2.2. High-flow sampling

Diel changes in discharge are likely to occur during snowmelt runoff, and the assumption of steady conditions is not valid. To accommodate for the transient conditions, a sampling sequence must follow the changes within a parcel of water as it flows through the study reach, which is called a Lagrangian sampling scheme (Meade and Stevens, 2007; Moody, 1993). The schedule requires a precise timing of water movement along the study reach. To prepare a schedule for these variable conditions, a rhodamine WT dye tracer was added to the stream to observe its breakthrough at downstream sampling points. The dye was added in the morning, and the arrival time at the six downstream sites was determined using a portable fluorometer. Arrival times, calculated from the breakthrough curves, were used to schedule the synoptic sampling in the afternoon when snowmelt runoff would affect the stream. Under high-flow conditions, it was necessary to place stream sampling sites near bridges and at locations where it would be safe to wade the stream.

2.2.3. Colloidal concentrations and analytical methods

Transport of metals in mine-affected streams is influenced by Fe-rich colloids (Kimball et al., 1995). For the low-flow study colloidal concentrations of metals were calculated by subtracting the metal concentration of an ultrafiltered, acidified (10,000 Dalton pore size) sample from an unfiltered, acidified sample. The unfiltered, acidified sample represents a total recoverable concentration with respect to Al, Fe and metals associated with the Fe-rich colloids. The ultrafiltered sample is a better measure of a dissolved concentration than a 0.45-μm filtered sample for metals like Al, Cu, Fe, Pb and Zn that tend to be associated with the Fe-rich colloids. Colloidal particles that contain these metals can pass through a